formances of the scholars in 60 classes of the Vienna public schools (*mental work of children*).

The carefully worked out results of this extensive investigation were presented in over 100 tables. The most important conclusions may be stated as follows:

1. If the weather exerts any influence at all its effects are restricted to relatively narrow limits.
2. Easy mental work is best carried on under only slight daily pressure changes.
3. Under rapid pressure changes (having periods of 4 to 20 minutes) there was a pronounced falling off in work accomplished, and a poorer condition in patients.
4. Higher temperatures and temperature variations, particularly those of a two-day duration, caused a falling off in mental work; while epilectics seemed to be sensitive to cold.
5. Correlation with other meteorological elements was generally less definite or quite impossible; the latter was particularly true for the quantity of ozone present.
6. If one desires to make use of the usual weather-descriptive methods it appears more desirable to select the isallobaric regions (those of rising and falling pressures) rather than the favorite isobaric regions of highs and lows. The isallobaric regions showed pronounced synchronal relations in all cases, even in the studies of the school children where the other relationships were rather indistinct.

The material collected has been but partially studied so far, and the results here summarized apply only to Vienna in 1912.

The methods employed revealed, of course, only a chronological relationship; direct effects could not be traced here even as well as they might through physiological experiments. However, although these methods do not by any means permit one to unravel the true causes of the phenomena by means of the merely accidental or essential concurrent circumstances, nevertheless these methods have the advantage, among other things, of broad foundations in every direction, of working under natural surroundings and the possibility of summarizing conditions that can not be directly realized in an artificial experiment. Disregarding even these advantages, these studies offer a guide to the direction in which results may be properly sought for in the future.

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## HUNTINGTON ON THE CLIMATIC FACTOR.[1]

By W. J. HUMPHREYS, Professor of Meteorological Physics.

This latest book by Prof. Huntington, of Yale, fully supports his reputation as a persistent worker, resourceful advocate, and delightful writer. As the title of the book indicates, climatology is the main topic, not climatology as a disconnected and isolated science, but climatology in its relation to and as interpreted by geology, botany, archeology, and ethnology.

Everyone must admit that climate is an important factor in a thousand things, some of which, like the age and growth of trees, the size and course of rivers, the area and depth of lakes, and even the development of nations and the evolution of the human race have accumulated innumerable and invaluable records; fragmentary to be sure, and hard to interpret, but never biased and, taken together, covering every age from the very present to the earliest geologic aeon. It is some of the more conspicuous of these records that Prof. Huntington and others, at the expense of a great deal of labor, have brought together and discussed in the book under review. For the data themselves we must be thankful. No climatologist whose vision extends beyond yesterday's meteorological records can afford to ignore them. In regard, however, to any climatic hypothesis one may fashion to fit the observed facts it is necessary to be conservative and cautious. Of course, a working hypothesis is often a great help to progress, and Prof. Huntington has wisely been bold enough to further his own work in this way. He assumes that during historic times there have been a number of extensive, probably world-wide, climatic changes, especially changes in the amount of precipitation; that they were irregular in occurrence, intensity, and duration; and that some of them lasted several centuries. This is certainly a good working hypothesis and the author legitimately and cleverly endeavors to support it with data from a number of independent sources. The big trees of California, for instance, are as independent of the Maya ruins of Yucatan as of the rings of Saturn, and yet in the hands of Prof. Huntington the Maya ruins and the big trees tell the same tale of centuries-long climatic changes. But in spite of all this cumulative evidence the author is frank enough to say of his hypothesis (p. 224), in the open-minded spirit of the true investigator:

> Doubtless it will be further modified; doubtless I have ascribed to it some results really due to other causes; but that is an inevitable stage of a new subject. The only question is: How far does the present theory harmonize with the great body of facts by which it has been or may in future be tested? So far as it does so, we may tentatively accept it. So far as it does not, it must be rejected.

Surely this statement is fair enough to disarm any combative opponent.

But to be more specific and more critical:

The interesting fact, discussed on pages 12 and 13, that in southern Arizona at high altitudes winter precipitation is greater than that of summer while at low altitudes it is less than that of summer does not seem to the reviewer to indicate, as suggested, any climatic peculiarity or to be at all mysterious. The winter precipitation in Arizona, as elsewhere, is largely the result of topographic deflections of otherwise horizontally moving winds, and hence is greatest at considerable altitudes. On the other hand, the summer precipitation is due almost wholly to the strong vertical convection of thunderstorms whose formation is especially favored by the high temperatures of the valleys and plains. In short, the phenomenon in question appears to be fully accounted for by the difference in the summer and winter processes of inducing precipitation; that is, topographic deflection and heat convection.

On page 90 it is stated that "the more severe climatic changes of the present time appear to be, in general, synchronous in the United States and Europe. This was evident in the summer of 1911, when England was so dry as to be changed from a green land to a brown, and the eastern United States had the hottest, driest season for a century." The first statement, that in general the climates of Europe and the United States vary together, is true, but the data for the single year 1911, or any other, is no proof of it. Besides, the statement that during the summer of 1911 "the eastern United States had the hottest, driest season for a century" may need some modification, in the light of the accompanying table made up from Weather Bureau records. Instead of that season being the "driest for a century," it appears actually to have been wetter than usual.

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[1] The Climatic Factor as illustrated in arid America. By Ellsworth Huntington, with contributions by Charles Schuchert, Andrew E. Douglass, and Charles J. Kullmer. Washington, 1914. vi, 341 p. 12 plates, 2 maps, 90 text cuts. 4°. (Carnegie Institution of Washington, Publ. No. 192.) $5.50.

*Departures of temperature and of precipitation from their normals, 1911.*

| Month. | New England. | | Middle Atlantic States. | |
|---|---|---|---|---|
| | Temperature departure. | Precipitation departure. | Temperature departure. | Precipitation departure. |
| | °F | *Inches.* | °F | *Inches.* |
| July | +3.3 | −0.3 | +1.6 | −1.2 |
| August | +0.2 | +1.2 | +1.1 | +3.3 |
| September | −0.8 | −0.5 | +1.6 | −1.3 |
| Season | +0.9 | +0.1 | +1.4 | +0.2 |

Chapter XI, "A method of estimating rainfall by the growth of trees," by A. E. Douglass, is quite the best discussion of this subject known to the reviewer. For a number of years Prof. Douglass has studied minutely and exhaustively the relation of the growth of trees, as shown by the nature and size of their "annual" rings, to the cotemporaneous weather in their immediate neighborhood. With both records, tree growth and weather, before one, the relation between them seems to be clear and obvious, and may justify Prof. Huntington in applying the same method to the big trees of California.

There is, however, great difficulty in interpreting the sequoia records. Though one ring, and that a ring all the way round, for each year is the rule there are many exceptions. Under the influence of certain conditions, especially of the seasonal distribution of precipitation, two rings may be deposited during a single year. On the other hand conditions occasionally obtain that permit but little if any annual growth. In addition to all this the records are still further complicated by the fact that the rings often are so fragmentary that one side of a large sequoia may register an age centuries greater than another side. Surely then the interpretations must be difficult. But even so the sequoia's weather records are valuable because, among other reasons, they are continuous for the same locality through the remarkable period of more than 3,000 years.

"The Shift of the Storm Track," by C. J. Kullmer (pp. 193–205), is a valuable contribution to climatology. It shows that the average storm track across the United States had practically the same location during 1899–1908 that it had two decades earlier, or during 1878–1887. According to the record the average storm track was a little farther south and a little farther west during the later than during the earlier period. It does not follow, however, at least it does not appeal to the reviewer as following, that there actually was a shift in the position of the average storm track. Many additional Weather Bureau stations were established during the interval between the two selected decades, and while those added in the East were relatively close together, and therefore could not materially have modified either the number of storms reported or their observed locations, the stations added in the South and West were widely scattered and must have altered both factors.

This consideration does not in the least detract from the value or excellence of Prof. Kullmer's paper, but it does seem to estop the assumption that any definite shift in a decade average path of storm tracks has, in this case, been actually observed.

On page 232 it is stated that "climatic changes are due primarily to a strengthening or weakening of atmospheric circulation." A strengthening or weakening of atmospheric circulation would, of course, be a climatic change within itself and would induce still other changes. It would seem better, however, in seeking a primary cause of climatic changes, to go back at least one more step to changes in temperature and temperature gradients, for temperature and temperature differences are at the bottom of all weather and all weather changes.

On page 234 the inception of the carbon-dioxide theory of the ice ages is, as usual, ascribed to Arrhenius. It may indeed have been entirely original with Arrhenius but, as a matter of fact, Tyndall suggested the same idea at least 35 years earlier.

On page 250 it is stated that "when the growth of a century or two is considered the trees are found on an average to grow relatively fast when the sun spots are at a maximum and slowly when they are at a minimum." Elsewhere (figs. 17 and 42, for instance) we are assured that in general tree growth and rainfall vary together and in the same sense. The inference, therefore, is that with maximum sun spots there is maximum rainfall and with minimum spots minimum rainfall.

Now, the fact that the average temperature of the entire world, or even of a single continent or broad zone, if not modified by some such accident as a veil of volcanic dust, is highest during spot minima and lowest during spot maxima is almost as definitely established as is the obvious fact that the average temperature of summer is higher than that of winter. This higher temperature must imply greater evaporation and also greater precipitation for the world as a whole; and, so far as studied, the records appear to support this conclusion. As most trees examined seem to contradict this conclusion, while those of Arizona confirm it (see Huntington's fig. 24), it therefore would appear that the influence of other climatic factors on tree growth, the importance of seasonal distribution of precipitation and of local peculiarities all combine to make it impossible to infer from the trees of a small number of places more than the broadest generalities about the climates of the past. But even this, and Prof. Huntington claims no more, is distinctly worth while.

The solar hypothesis as developed in Chapter XIX, the assumption that changes in the solar constant have been coincident with and the chief causes of all climatic changes, including those of the glacial and interglacial epochs, frankly does not appeal favorably to the present reviewer, and Prof. Huntington by his commendable courage to follow this hypothesis to its logical conclusion has rendered its acceptance vastly more difficult. On page 261 he says: "With them [solar changes], however, and perhaps *inseparable*[2] from them, occur changes in the earth's interior whereby crustal deformation is induced."

Probably to most people this will appear as a reductio ad absurdum, and therefore a compelling reason—if they accept the apparently sound logic upon which it is based—for abandoning altogether the solar hypothesis of great climatic changes, such as undoubtedly occurred time and again during the geologic past.

The final chapter (pp. 265–296), "Climates of Geologic Time," is by Charles Schuchert, a master of this subject. It presents no obvious ground for criticism and even praise would be superfluous.

To sum up: The book, as a whole, is excellent. It will interest many people and some, the climatologist among them, must study it carefully. Whether the conclusions are accepted or rejected, the evidence can not be wholly ignored. Doubtless some day extensive revisions will be needed—and made—for the subject is new and the conclusions confessedly only tentative. The book should be carefully read. It abundantly deserves it, but read as the author would have it read, with mental reserve and discrimination. Nor should it be forgotten that the subject of climatic changes has two sides, a pro and a contra.

Those who wish both sides will find the contra well summed up by Prof. Gregory,[3] under the caption "Is the Earth Drying Up?" The pro side is new; its ablest exponent, Prof. Huntington; its best defense, the book under review.

[2] Italics are the reviewer's.
[3] Geographical journal, London, Feb., Mar., 1914, 43: 148–172, 293–318.